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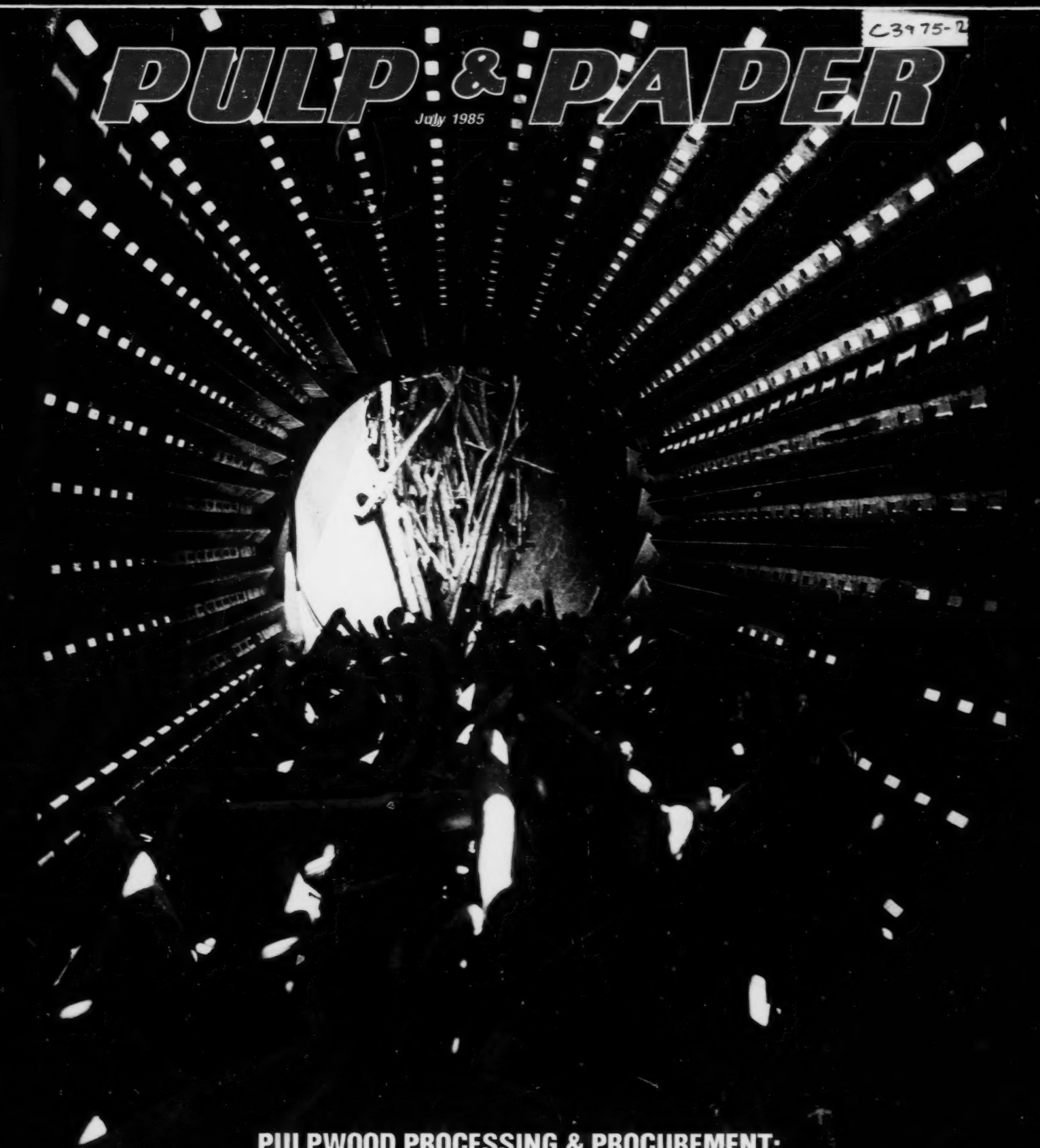
PULP & PAPER

July 1985



PULPWOOD PROCESSING & PROCUREMENT:
Planning and management keep the resource renewable

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Number 7

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Pulpwood is processed with modern and highly efficient equipment at Georgia-Pacific's Cross City, Fla., chip mill. These logs leaving the barking drum will go straight line to the chipper. (Staff photo by Ken Patrick.)

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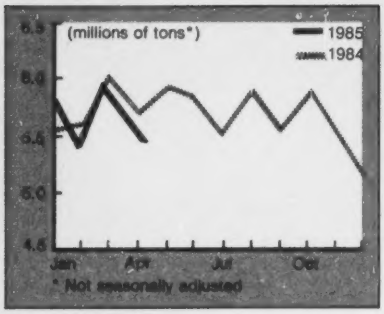
U.S. paper and board production



U.S. production of paper and paperboard in April continued to lag year-earlier levels, according to the American Paper Institute, weighing in at 5.46 million tons, down 5.2% from April 1984. API's moving average for March and April showed production continuing to trend downward, as it has since January, although preliminary data for May indicate that the slump may have bottomed out. The trend position stood at at 65.1 million tons in April, down 5.4% from January.

Among major grades, coated paper and uncoated free-sheet shipments were up, while tissue also registered gains. Packaging grades fell off sharply, however, and newsprint was also down. Kraft linerboard suffered a sharp 10.0% drop in April as a number of mills took downtime to reduce excess inventory, while production for export dropped 16.0% in April and 28.2% on an annualized basis. Corrugated box shipments rose 2.1% in April, according to the Fibre Box Assn.

Canadian newsprint shipments rose 7.4% in April, the Canadian Pulp & Paper Assn. said, while U.S. imports of Canadian newsprint jumped 30.4%. Operating rates climbed to 91% in April, up from 89% in March. ■

	Latest month (000 short tons)		% change from year ago	Annualized year-to-date (000 short tons)	% change from year ago
PAPER & PAPERBOARD PRODUCTION[1]					
Newsprint	Apr.	427	−8.2	5,493	−1.3
Uncoated groundwood (s)	Apr.	124	−2.4	1,491	−7.2
Coated paper (s)	Apr.	502	−1.0	6,312	1.7
Uncoated free sheet (s)	Apr.	813	9.3	9,564	2.2
Other printing/writing	Apr.	99	−23.8	1,224	−18.0
Total packaging and other paper (s)	Apr.	406	−18.3	5,253	−10.2
Tissue	Apr.	399	−1.5	4,911	1.2
Total paper	**Apr.**	**2,788**	**−3.0**	**34,468**	**−1.3**
Unbleached kraft paperboard	Apr.	1,284	−10.0	16,423	−3.8
Semichemical medium	Apr.	411	−3.7	4,973	−3.7
Bleached paperboard	Apr.	342	−1.7	4,008	−2.3
Recycled paperboard	Apr.	637	−7.3	7,677	−4.1
Total paperboard	**Apr.**	**2,674**	**−7.4**	**33,102**	**−3.7**
Total U.S. paper and paperboard output	**Apr.**	**5,462**	**−5.2**	**67,570**	**−2.5**
PULP, WASTEPAPER & FIBER[2]					
Total U.S. woodpulp production	Mar.	4,819	−0.8	55,160	−0.6
Market pulp production	Mar.	610	3.0	7,108	5.0
Wastepaper consumption at paper/board mills	Mar.	1,362	−1.9	15,583	−2.8
Pulpwood consumption (cords)	Mar.	7,651	−47.2	88,180	−52.2
CONVERTED PRODUCTS STATISTICS[3]					
Corrugated box shipments (billion ft²)	Apr.	22.582	2.1	89.823[6]	0.2
Containerboard inventories at U.S. box plants and mills	Apr. 1	3,023	2.2		
INTERNATIONAL TRADE[2]					
U.S. paper imports (including products)	Mar.	1,046	28.0	11,233	12.7
Imports of Canadian newsprint	Mar.	759	30.4	8,154	10.6
U.S. paper exports (including products)	Mar.	355	−9.7	3,932	−6.6
Exports of unbleached kraft linerboard	Apr.	142	−16.0	1,531	−28.2
Exports of woodpulp	Mar.	399	6.7	3,688	−3.0
Norscan pulp inventories[4]	Apr. 30	1,589	−9.8		
Norscan pulp operating rates[4]	Apr.	76%	90%	92%	87%
CANADIAN STATISTICS[5] *(reported in metric tons)*					
Total newsprint shipments	Apr.	753	7.4	3,011[6]	10.7
Operating rates	Apr.	91%	89%	95%	85%
Inventories held by U.S. consumers	Apr. 30	1,519	27.8		
Other paper/board shipments	Apr.	255	17.5	993	11.1
Woodpulp shipments (export only)	Apr.	551	27.3	2,154[6]	12.2
Operating rates	Apr.	77%	80%	86%	74%

1. American Paper Institute. 2. API, Bureau of Census, American Pulpwood Assn. 3. Fiber Box Assn., Paperboard Packaging Council. 4. North American/Scandinavian paper-grade market pulp. 5. Canadian Pulp & Paper Assn. 6. Not annualized. (s) = shipments.

RECYCLED PAPERBOARD: Prices erode as market reacts to poor demand; capacity holds steady

Grade structure: Made almost entirely from secondary fiber, recycled paperboard includes boxboard, corrugating medium, linerboard, core, can and tube stock, and gypsum linerboard but excludes other construction papers and boards. It is divided into three categories: folding boxboard, setup boxboard, and paperboard. Folding boxboard is clay coated, while setup boxboard is uncoated. Recycled paperboard can be produced on both fourdrinier and multi-ply paper machines.

Production/capacity: Production rose 6.2% to 7.9 million short tons in 1984 from 7.4 million tons in 1983. Demand, however, began to slide in the early part of 1985 and for the first quarter was down 3.1% compared with a year ago, according to American Paper Institute figures. Production of boxboard held fairly steady for the first quarter, but output of gypsum liner was off 15%, while recycled tube, can, and drum stock was down 4.6%.

Once again, capacity increases will be insignificant in 1985, rising just 0.6% to 8.8 million tons from 8.7 million tons in 1984, according to API. This should keep operating rates around 92%, a bit above 1984's 90.3%.

Ownership changes could alter this forecast. Federal Paper Board Co., for instance, acquired and soon afterward shut down Nabisco Brands Inc.'s Marseilles, Ill., recycled boxboard mill. Champion International Corp. recently sold two recycled paperboard mills and six folding carton plants to Trident Associates, an investment firm, which apparently will run the plants. International Paper Co. purchased and plans eventually to reactivate an idle recycled containerboard in Riegelsville, Pa. In addition, Inland Container Corp.'s 175,000-tpy recycled linerboard mill in Ontario, Calif., is expected to be completed late in 1985.

Outlook: While the forecast for boxboard at the beginning of the year appeared promising, demand began to slip in the first quarter and slid faster in the second quarter, causing prices to deteriorate.

While housing and auto markets remained relatively firm through the first quarter and housing starts began to pick up in March, keeping the lower grades active, demand for folding carton was sluggish. Some observers attributed the fall off in orders to the surge in imports of finished goods already packaged.

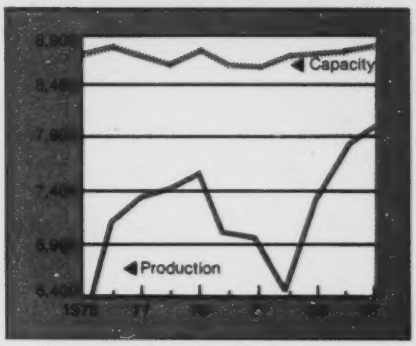
Recycled paperboard production is expected to reach 8.1 million tons in 1985, 3.1% ahead of last year. Prices, though, will be weak in the folding carton market due to continued competition from alternate materials, especially solid bleached sulfate (SBS) and solid unbleached sulfate (SUS).

Adding to the price pressure has been a sharp drop in wastepaper costs (as much as 50% for some grades) since the beginning of 1984.

Prices: Prices for the lower grades such as chipboard and white-lined vat should remain flat throughout the second half of 1985. Clay-coated recycled board prices, however, were volatile through the first half, with spot market levels considerably lower than the December 1984 list. Market executives expect some improvement in transaction levels later in the year, but no list price increases.

Clay-coated 20-pt folding boxboard (rolls), $/short ton, year-end: 1975, $257; 1976, $262; 1977, $284; 1978, $305; 1979, $355; 1980, $380; 1981, $400/425; 1982, $380/425; 1983, $370/425; 1984, $375/425. Bending 20-pt chipboard (rolls), $/short ton, year-end: 1975, $204; 1976, $212; 1977, $219; 1978, $225; 1979, $260; 1980, $260/275; 1981, $270/280; 1982, $280; 1983, $280/300; 1984, $300.

Markets: Market demand for recycled paperboard grades, measured by their capacity share is: folding boxboard, 30.0%; setup boxboard, 3.6%; corrugating medium, 17.0%; gypsum linerboard, 14.2%; linerboard, 4.8%; container chipboard and filler board, 2.9%; other paperboard, 27.3%. ■



	1983	1984	1985e
Production[1]	7,398	7,858	8,100
Capacity[1]	8,692	8,702	8,756
Utilization rate	85.1%	90.3%	92.5%
Imports	50	69	80
Exports	150	169	180
Apparent U.S consumption	7,298	7,758	8,000
lb/capita	63.2	66.5	67.9
GNP ratio	4.82	4.79	4.80

e = Estimate.
1. American Paper Institute data.

	Annual capacity	Market share (%)
1. CCA[1]	640	7.3
2. Sonoco Products[2]	568	6.5
3. Jefferson Smurfit	534	6.1
4. Newark Group[3]	500	5.7
5. Champion Intl.[4]	480	5.5
6. Caraustar[4]	450	5.1
7. National Gypsum[5]	400	4.6
8. Rock-Tenn[7]	307	3.5
9. Federal Paper	300	3.4
10. PCA	189	2.2

Market share of top five companies: **31.1%**

Market share of top ten companies: **49.9%**

Total U.S. capacity (1985): **8.758 million short tons**

1. Sold the Chicago, Ill., Cincinnati, Ohio, and Chattanooga, Tenn., uncoated recycled board mills to Caraustar Industries Inc., September 1984.
2. Closed Richmond, Calif., core and tube stock and chipboard mill, Mar. 1, 1984.
3. Sold Uncasville, Conn., mill to Stone Container Corp. and bought Stone's Franklin, Ohio, and Mobile, Ala., mills, August 1984.
4. Acquired St. Regis Corp.'s recycled board mills in merger.
5. See footnote 1.
6. Inoperative Kalamazoo, Mich., gypsum linerboard mill is included.
7. Bought Stroudsburg Paperboard Co.'s Stroudsburg, Pa., mill, October 1984.

Despite recent sluggishness in the economy, U.S. pulp and paper companies now plan to spend $7.59 billion on new plants and equipment in 1985, up 6.2% compared with 1984. The new figure represents an increase of about 1.7% over earlier 1985 plans. About 52% of the total is destined for capacity expansion and 48% for replacement and modernization, according to McGraw-Hill. That compares with a 53%/47% split in 1984.

Preliminary plans for capital expenditures in 1986 were also revised upward in the latest survey. Papermakers now plan to spend about $9.1 billion in 1986 on capital projects, up 8.3% compared with earlier planned outlays. Some 55% of that total is slated for expansion projects. Outlays for 1987 and 1988 are estimated at $8.34 billion and $7.85 billion, respectively, McGraw-Hill said.

Planned spending increases are less robust in pulp and paper than in other nondurable manufacturing industries which, except for textiles, plan double-digit hikes in 1985 capital outlays. Papermakers are building on a stronger 1984 spending base than other nondurables manufacturers, however, since they were quicker to boost spending last year than the others.

Overall, U.S. business is less bullish on spending plans than earlier this year, when a 10.9% increase was planned. U.S. companies now plan to spend $388.4 billion on new plants and equipment in 1985, up 9.9% compared with last year. ■

IP offers early retirement

International Paper Co. has offered early retirement to 1,000 of its employees in the U.S. The company also plans to lay off an undetermined number of salaried employees, a company spokeswoman said. IP had a work force of 32,300 at the end of 1984.

"The strong dollar and Canadian imports have turned building materials into a disaster area," the spokeswoman said. "The demand is there, but because of subsidized Canadian lumber, our building products can't compete." ■

SALES & EARNINGS

Canadian first-quarter earnings increase 535%

Total earnings of C$88.3 million in the first quarter of 1985 for 13 Canadian companies compare healthily with the $13.9 million recorded for the 1984 period. Total sales for the period were up 18.2% at $3.4 billion, compared with $2.9 billion for the first quarter of 1984.

Abitibi-Price Inc. posted a 129.3% increase in earnings, to $23.7 million from $10.3 million, which it attributed to an increase in sales, higher operating levels, and the favorable U.S.-Canadian exchange rate.

Although down from fourth quarter of last year, Consolidated-Bathurst Inc.'s first-quarter 1985 earnings improved 59.5% over the 1984 first quarter, based on sales of $411.6 million, with the pulp and paper group showing improved earnings.

Improved operation of the Athol-ville, N.B., pulp mill and continuing good demand for both coated and uncoated groundwood papers, plus improved demand for wood-free printing papers, were cited by Fraser Inc. as contributing to better earnings over the last two quarters of 1984. However, earnings for first quarter of this year were down 54.8% from the first quarter of 1984.

After reporting a 16.3% increase in earnings for the quarter, Domtar Inc. announced plans to propose a 2-for-1 stock split of common shares at its June 3 annual meeting. President and CEO James Smith said expectations for newsprint, pulp, and packaging are uncertain, but that business papers and construction materials, among others, should perform well.

The East/West split (with the West on the losing side) faded as only one company, Canfor Corp., reported an earnings loss. In the first quarter of 1984, British Columbia Forest Products Ltd., Canfor, Crown Forest Industries Ltd., and MacMillan Bloedel Ltd. all reported losses.

However, MB stated that first-quarter 1985 results "are still far from satisfactory and reflect oversupply conditions for most of the company's major product lines," and that the net did not cover preferred dividend requirements. MB said that it would not pay its regular quarterly 2% common stock dividend but would pay annual dividends at a time and in an amount yet to be decided. This will "preserve retained earnings."

The Canadian paper industry experienced a healthy first quarter.

	First quarter (C$000)			
Companies	**Sales**	**Change 1985/84**	**Earnings[1]**	**Change 1985/84**
Abitibi-Price	C$581,433	23.5%	C$23,723	129.3%
British Columbia Forest Products	277,600	62.1	8,000	n.m.[2]
Canfor	248,500	9.8	(16,600)	n.m.
Cascades	53,923	51.3	2,409	8.6
Consolidated-Bathurst	411,600	4.3	19,300	59.5
Crown Forest Industries	192,900	42.2	3,000	n.m.[2]
Domtar	527,300	3.6	28,800[3]	26.3
Donohue	110,800	6.2	6,300[4]	1.6
Fraser	142,321	9.0	1,830	−54.8
Great Lakes Forest Products	148,162	8.1	4,838	2,248.5
MacMillan Bloedel	538,600	30.8	2,600	n.m.[2]
Rolland	75,700	11.2	1,355	−35.5
Scott Paper	68,702	12.0	2,762	6.8
Total	**3,377,541**	**18.2**	**88,317**	**535.1**

1. Income after taxes from continuing operations, excluding most significant nonrecurring items in both years.
2. Not meaningful due to loss in 1984 quarter.
3. In latest quarter, a special gain of $5.2 million from U.S. tax credits made final net $35 million. In year-ago quarter, a special gain of $5 million made final net $27.8 million.
4. 1984 earnings restated by company to include investment tax credit.

( ) = Loss. n.m. = Not meaningful.

MARKET PULP

Few greenfield market pulp mills seen for the '80s

While market pulp demand may remain strong through 1986, the many new expansion projects starting up in various parts of the world will probably keep the market in oversupply over the next two to five years, Jaakko Pöyry, chairman of Jaakko Pöyry Group, told a recent Finncell market pulp symposium held in Nice, France.

These new projects have significantly expanded world market pulp capacity over the past two years and will continue to increase supply for a few more years. The total additional capacity from these projects is more than 2 million tons, or close to 10% of world market pulp consumption, he noted.

"Against this background, my conclusion is that pulp prices will remain depressed for several years, possibly for the rest of this decade," he said. "If this holds true, the profitability of the pulp industry will remain low in most regions, constituting a major obstacle to new pulp mill expansions." Few greenfield market pulp mills are likely to be built anywhere in the world.

Soaring capital costs. In addition to poor profitability, another deterrent to pulp mill expansion is the sharp rise in investment cost for new mills. In the 1960s, a new kraft pulp mill in Sweden with a capacity of 100,000 tpy would have cost $25 million. In 1984, the size would have been 300,000 to 350,000 tpy, and it would have cost about $300 million—even more if infrastructure is included. This rise in cost has been due to the growing size of the new mills in an effort to take advantage of economies of scale.

Pöyry said total production costs for a new bleached kraft softwood pulp mill in Sweden are about $530/metric ton and range from about $600 to $630 in other regions of the world. This means that the present price of $360 to $390/metric ton for NBSK is too low to justify investment in a new pulp mill.

The situation is the same for a new bleached hardwood pulp mill. A new mill in Sweden or Portugal would have the lowest costs—about $420 to $430/metric ton, while costs elsewhere would be higher, ranging from $570 to $580/metric ton. Again, the current price of $330 to $350 for hardwood kraft pulp is too low to justify investment in a new mill, according to Pöyry.

He made further estimations for different regions of the world. The softwood pulp production costs of North American producers are more than $100/metric ton higher than Swedish mills for pulp delivered in western Europe. "The present sales price is barely sufficient for the best Swedish mills but clearly unsatisfactory for the North American mills," he noted. ■

New market pulp mills starting up over the 1984-86 period.

Company	Location	Startup	Capacity/grade (000 metric tpy)
North America			
Leaf River Forest Products	New Augusta, Miss.	9/84	335 BSK, BHK
International Paper	Georgetown, S.C.	9/84	280 BSK, BHK
Champion International	Quinnesec, Mich.	1986	260 BHK
Latin America			
Celgusa	El Rancho, Guatemala	2/85	100 BSK
Aracruz	Aracruz, Brazil	2/84	60 BHK
Manasa	Brazil	1985	60 BHK
Africa			
Mondi	Richards Bay, South Africa	11/84	150 BHK
Sappi	Ngodwana, South Africa	1985	50 BSK, BHK
Western Europe			
Soporcel	Leiroa, Portugal	6/84	300 BHK
Pols	Pols, Austria	12/84	190 BSK
Metsä-Botnia	Aanekoski, Finland	5/85	100 BSK, BHK
Eastern Europe			
Czechoslovakia	Paskov, Czechoslovakia	6/84	200 BSS
Asia			
Taiwan Pulp & Paper	Hsinying, Taiwan	2/85	130 BHK
Indah Kiat	Sumatra, Indonesia	10/84	100 BHK
Total			2,315

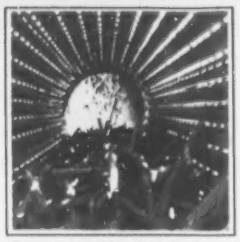
BSK = Bleached softwood kraft. BHK = Bleached hardwood kraft.
BSS = Bleached softwood sulfite.
Source: Jaakko Pöyry.

U.S. market pulp suppliers to remove 2 million tons by '92

"U.S. market pulp producers will withdraw at least 2 million tons of capacity from the market by 1992," H.C. Bowen Smith, managing director of stock research for Salomon Brothers Inc., told a recent Finncell market pulp symposium in Nice, France. "If they do not, they will be making a serious mistake" for the following reasons:

- The majority of U.S. market pulp producers are already partly integrated and have developed distribution systems for printing/writing papers.
- The strong dollar has made U.S. producers less competitive and has resulted in poor profits. These conditions are likely to exist for a long time.
- U.S. wastepaper exports, which have grown dramatically in recent years, are indirectly competing with U.S. pulp exports.

Running to pay off debt. Smith said that on a variable-cost basis, most U.S. market pulp producers are still making money. He estimated the average variable production cost of a U.S. southern softwood producer at $385/metric ton, and a hardwood producer at $325/metric ton (including $45/ton delivery cost to Europe).



PULPWOOD PROCESSING

Industry commitment to reforesting private lands is crucial to the future

Current reforestation efforts impact only 1% of private landowners; more effort is needed to increase yields and ensure profitable future forests

By R. SCOTT WALLINGER

■ Many paper mills depend on nonindustrial private forests for more than half of their wood supply. These forests are owned by small landowners—a group of some 8 million individuals who own almost 60% of U.S. forestland. Industrial concern about small landowners as pulpwood suppliers has centered on three uncertainties: availability, cost, and management of the land for desirable species and growth rates.

Availability and cost are not seen as significant short-term issues. Land management intensity, tree growth, and reforestation are the real concerns mills have regarding small landowners. Several opportunities exist to increase this source of wood. The land and forest are important, but the real focal point for improved private forest management is the landowners themselves.

TYPES OF LANDOWNERS. Many owners are motivated to practice good forestry by a strong sense of stewardship. They want to leave their forestland as good as they found it, or better, and this desire is enhanced by anticipation of future profits. These owners generally seek and accept professional forestry advice. These are the kinds of owners that are recognized under the Tree Farm Program, administered by the American Forest Institute, and directly managed by state forestry groups. Much of what industry and government agencies are doing to educate forest owners and to recognize good forest management enhances feelings of stewardship.

Other owners have other objectives. To some, ownership of forestland is a sideline to their main interest: a farm, a residence, or a recreation area. Some owners are speculators, looking for returns from the sale of the property. They are unlikely to increase their holding costs to make investments in forest management. Another category of forest owner could be described as custodial, with no investment strategy to speak of.

It is also not unreasonable to expect that many landowners are skeptical about the profitability of investments in forest management. Any return on investment must come solely from stumpage, without value added from manufacturing or other areas that rationalize industrial forest investments. A popular cartoon from *New Yorker* magazine shows a man in the forest telling his son, "It's good to know about trees. Just remember, nobody ever made any big money knowing about trees."

There are other barriers to forest management. A survey taken in the U.S. South in 1983 found that of the landowners interviewed, 88% were more than 65 years old, 24% were retirees, and 40% had annual incomes of less than $25,000—difficult prospects for forestry investments with delayed returns.

Industry cannot expect yields from small landowners' property to equal those from industrial forests, given industry's greater share of high-productivity sites and ready access to intensive tree-growing technology. Many small landowners will continue to rely on relatively simple management practices that are less intensive than those used on industry lands.

FOREST MANAGEMENT CHOICES. Opportunity exists for improved management but there is no consensus on how to obtain it. Some companies assume that the marketplace will provide the necessary incentive. These companies aggressively buy stumpage when they want it, at the price it takes to get it, but have opted out of the persuasion business on forestry.

Other companies are directly involved in improving the management of these lands. The major industry ef-

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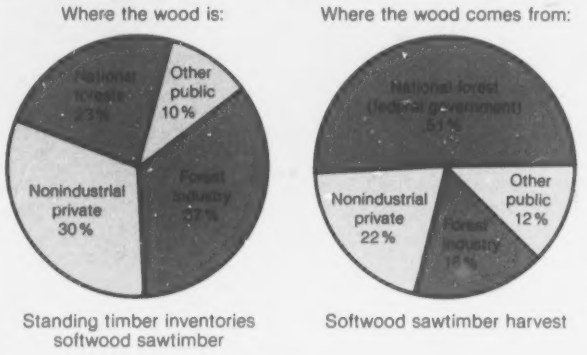
FIGURE 1: **Breakdown of standing softwood sawtimber inventories and harvest.**



Source: National Forest Products Assn.

FIGURE 2: **Private nonindustrial lands productivity: wood consumer goals compared with Resources Planning Act of 1980.**

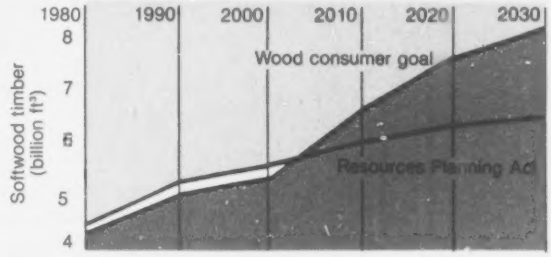


Chart courtesy of National Forest Products Assn.

fort is in the South, through leasing and management assistance. The most recent information, covering nearly 70 companies, shows corporate involvement in managing the lands of others on a little over 5 million acres, 2% of the small landowner total. The acreage is almost equally split between leases and landowner assistance programs. Nearly half of the companies surveyed plan to expand their activity in this area. The majority of the remaining companies expect to maintain their activity. Leasing is on the decline, and management assistance is on the rise.

Landowner assistance programs are based on corporate commitment, through direct involvement of company personnel to persuade and assist landowners to intensify forest management on their lands. At the most basic level, this may be only verbal advice from a company forester to a landowner. The advice may include distribution of literature on how to get government cost-sharing payments, how to take advantage of tax incentives, how to find consulting foresters and contractors for timber stand improvement, and how to plant trees.

At the next level of involvement, some companies will do the reforestation job, either with their own equipment or with contractor equipment, at cost, with no charge for developing a management plan, professional advice, or administration of reforestation work. In some cases, this assistance may involve a negotiated agreement for a first right of refusal on the eventual timber sale.

High levels of involvement offer other options. A participation lease or one-rotation lease is an arrangement whereby the company bears all the costs of reforestation. In an annual rental situation, the company bears the cost of reforestation, pays a rent that is adjusted on a regular basis of inflation, and receives the harvest from the landowner.

In most cases, future harvests will be purchased either through a one-on-one negotiated agreement with the landowner or by competitive bidding. The real value of company landowner assistance programs is the inside track gained by fostering a sustained relationship with the landowner.

Most companies with landowner assistance programs find it to be a reasonable companion to the more capital-intensive programs on their own land. There are additional benefits. Neighbor-to-neighbor good community relations invariably lead to immediate returns in terms of increased stumpage acquisition. Satisfied landowners recruited into the American Tree Farm System are often "adopted" into individual company's landowner assistance program. They are often sympathetic to the company's local, state, and national government relations goals and can be very valuable allies.

STRATEGIES EXPLAINED. Companies that have a strong corporate commitment to assisting landowners do so for strategic wood supply purposes. Some of the methods they use for success in this commitment are explained below.

Reforestation assistance is most effective at the time of harvest. It is most economical to replant pine immediately following harvest, and this is the time the landowner has funds available to spend on reforestation. The bond of trust established between the company and the landowner because the harvest has been done in an acceptable fashion can logically be extended to reforestation and even to the next timber sale.

The program needs to be a full-time activity, completely coordinated with wood procurement. Regular contact between the landowner and the forester must be maintained on a one-to-one basis. Demonstrations, advertisements, literature, and radio and television spots can pique a landowner's interest but are no substitute for quality service on the ground. The service has to be given when and how the landowner wants it and must be designed to meet his or her objectives. Individuals do not make personal investment decisions based on the advice of a broker they do not know and trust, and the same can be said for any landowner investing his or her capital in forestry.

One wonders why more companies aren't involved in private forest assistance. Why are industry-landowner assistance activities being performed on only 3 million acres, only 1% of the small landowner forest acreage in the country?

In many cases, corporate motivation simply is not present. In a survey of 110 forest products companies, only 33 required their foresters to discuss regeneration alternatives with landowners when the company purchased their timber. Two thirds of the company officials surveyed believed that reforestation of private timberlands is not a priority or should be motivated by either

FIGURE 3: **Planting and seeding on private, nonindustrial lands in the U.S., 1952-82.**

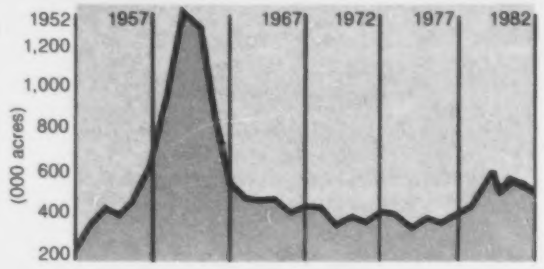


Chart courtesy of National Forest Products Assn.

government agencies or trade associations.

Direct contacts with landowners for stumpage purchased by pulp and paper company employees account for less than a third of the volume harvested in the South. In most areas, the majority of contacts are made by timber dealers or loggers. Unless there is a workable referral system to a company forester, the timber buyer is not likely to give priority to reforestation. This is unfortunate because the timing is right, the bond of trust for the harvest has been established, and this opportunity soon may be lost.

Industry is not the only management assistance delivery system. Some large-acreage owners hire consulting foresters, and many states provide public employees to do the job. Industry programs are only a part of the overall delivery system.

After motivating the landowner to reforest, the second step, from the landowners' point of view, is how to finance it. Shall some of the harvest proceeds be dedicated to reforestation? Many landowners do this but many will not unless they get some help.

Some assistance is available from government forest management incentives, or cost sharing. The federal government provides $25 million a year in cost sharing, generally on a 50:50 basis. Several states have similar cost-sharing programs. There is a difference of opinion within the industry over the relative value of cost-sharing programs, for reasons too numerous to discuss in this article.

Forest owners themselves rank cost sharing first among incentives to practice forest management. With agricultural subsidies running $20 billion a year, forest landowners are pleased with a modest $25 million of forestry cost sharing. Landowners also appreciate tax breaks, and surveys show they would like even better tax incentives than are now available.

Company foresters who deal daily with landowners report that for many of them, cost sharing is essential to the decision to reforest. Ten years of federal cost sharing have resulted in 2.5 million acres of reforestation and timber stand improvement.

What happens if the achievable opportunities for increasing the productivity of nonindustrial private forests are not met? There aren't any clear answers, except in the pine forests of the South. The best that can be said is that much of the uplands that aren't reforested to pine will revert to hardwoods, which have one fourth to one third the growth rate of pine. These stands will need an extra decade or two until the next harvest, and they are not as efficient to harvest.

SUMMARY. Nearly 60% of the commercial timberland available to generate the future wood supply is owned by 8 million private individuals. Future yield from most landowners' tracts will not approach yields expected from large-scale industrial lands.

Direct company assistance to landowners is a useful strategic policy for those companies committed to a quality, on-the-ground program. It gives a competitive edge today and should be a greater advantage in the future. These programs are not just an exercise in social responsibility or public relations. They are a practical part of the ongoing wood procurement effort, and they strengthen current fiber procurement in many cases. More important, when company-owned lands reach their capacity to produce, landowners' wood is the only supply to support major expansions in the domestic and export markets.

Logging or harvesting are still the most significant management practices that occur in any forest. If logging is accomplished with the future forest in mind, future forest growth and productivity will be positively affected, and financial yields to landowners will be greater. Much more can be done to promote the independent contractors' positive involvement in reforestation.

The solution to small landowners' forestry problems does not lie with national trade associations, nor will it be resolved by corporate discussions. It is a highly localized matter that requires forester contact with landowners. The structures and vehicles for coordinated action are already in place in state forestry associations and the American Tree Farm System.

There are mixed perceptions of the Tree Farm Program. It continues to recognize landowners who are forestry leaders, and it is an outstanding vehicle to talk forestry to the public. But in may states the local Tree Farm committees, sponsored by the state forestry associations, are the front line in selling forestry to all landowners. Where progress through those bodies is lacking, it is because industry commitment and support are lacking.

Second, two thirds of the time industry is missing the sale when the current crop of trees is cut. Brochures, advertisements, and gimmicks are no substitute for direct sales. Once the trees are gone and the money is spent, reforestation is a tough sell. If the forest product companies want to sell reforestation, they must become good salespeople.

Finally, the commitment must become part of a company's culture if it is to be sustained. This requires individual commitment. Efforts to achieve customer satisfaction, product quality, and production efficiency do not come without senior management commitment, and there is no reason to believe landowner assistance is any different. ■

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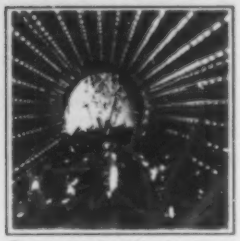
APA's fifty-first annual meeting was held in Washington, D.C., Mar. 17-19, 1985. The theme, "Fiber Supply Outlook," focused the general session presentation on future wood supply issues.



PULPWOOD PROCESSING

U.S. pulpwood cost outlook is good,

Most areas will have no problems with near-term pulpwood supplies; prices should be stable in all but the South, where a small rise is foreseen

■ The five forested regions of the U.S. provide the majority of the wood supply for the domestic pulp and paper industry. These five regions are the Northeast, the Appalachians, the Lake States, the West, and the South. Each region has unique factors that affect wood supply, costs, and procurement patterns. This article will discuss the cost of pulpwood and variables that will influence costs over the next few years.

The five regions differ in land ownership and in volume requirements for pulpwood. Several tables are included in this article to help quantify the differences in comparative terms. Table 1 illustrates regional land ownership pattern differences and sets the stage for later conclusions about the supply of standing timber. Note that nonindustrial private forest (NIPF) owners are important in all regions but the West.

Table 2 shows differences between the five regions in wood consumption by species and in pulpwood consumption. It also shows the concentration of softwood consumption in the South and West.

With such varied conditions, the relative wood cost component of pulp production can be expected to vary, and it does. Table 3, developed from American Pulpwood Assn. (APA) estimates, shows the percentage contribution of delivered wood costs to the cost of pulp at the paper machine wet end for 1983. The variations between regions are interesting features of Table 3. Delivered wood costs in the South are a higher percentage of pulp cost, not only because of the higher cost of softwood but also because mills in the South tend to be larger than those elsewhere and produce more unbleached pulp. Economies of scale and less bleaching result in lower mill costs. Wood costs that range from a third to more than half of the cost of producing pulp are significant, as these costs can affect the future viability of the industry.

Table 4 has the 1983 percentage data on wood costs shown in Table 3, but the corresponding 1973 data and the reduction in cost percent during the ten years between them is also included. The proportion of pulp cost attributable to delivered wood has decreased, and in some cases the decrease has been substantial. This reduction, however, is primarily a result of increases in mill energy costs. Delivered wood costs have increased at or below the rate of inflation. Improvements in logging efficiency have increased at or below the rate of inflation and have helped curb increases in wood costs during this period.

Form and source also affect cost. Table 5 lists "roundwood," meaning sections of trees in lengths ranging from four feet to the whole tree stem. The "chips" category refers to those chips produced at locations remote from the pulp mill, generally as residues from lumber and plywood manufacture. This category also includes chips produced at satellite chipping facilities.

Company-owned and leased lands are controlled sources for roundwood. The NIPF listing indicates roundwood from small, nonindustrial private forest owners. Public sources are federal and state government-owned lands. "Controlled chips" are those produced by sawmills owned by or under contract to the pulp company, and "open market chips" come from sawmills indepen-

This article is based on a roundtable presentation by three forest industry executives: C.P. Nielsen, vice president, Forest Products Group, Owens-Illinois Inc., Toledo, Ohio; C.R. Mordecai, general manager, Woodlands Div., Union Camp Corp., Savannah, Ga.; and Ralph Peinecke, vice president of Timberland Resources, Boise Cascade Corp., Boise, Idaho.

TABLE 1: **Ownership of commercial forests.**

	Regions				
	NE (%)	AP (%)	LS (%)	S (%)	W (%)
Industry	31	6	8	19	11
Public	6	12	39	9	69
NIPF*	63	82	53	72	20

*Nonindustrial private forests

TABLE 2: **Pulpwood consumption (million cords).**

	Regions				
	NE	AP	LS	S	W
Softwood	4	1	2	38	14
Hardwood	2	3	4	10	1

regional supplies appear adequate

dent of the pulp company.

Examining the fee and leased-land roundwood line in Table 5 shows a heavier dependence on these lands in the Northeast and South, where the major corporate landholdings are located. Roundwood from nonindustrial private owners is of the least significance in the West, and public ownership is an important source in both the Lake States and the West. The heaviest integration of pulp and solid-wood products is in the South and the West. Controlled chips are important factors in those regions.

Table 6 shows the delivered cost of roundwood divided into components for the same regions appearing in Table 5. Stumpage here is shown at fair market value, which means that stumpage from controlled sources not competitively priced is stated at prices equivalent to those paid to landowners on the open market. As might be expected, in New England, the Appalachians, and the Lake States, the stumpage cost component is smaller than that in the South and the West because of fewer competitive forces, lower tree values, and a heavy hardwood component.

Harvesting costs include all functions from felling to loading on board trucks. Harvesting costs in the South are favorable in comparison to those in other regions.

Transportation and road costs include all modes: truck, rail, and in a few cases, water and the road construction and maintenance costs associated with trucking. Again, the South has favorable costs.

Other costs include wood procurement and forest management personnel and equipment costs as well as all other woodlands department overhead and taxes.

Often the focus on wood supply costs and their relation to the future competitiveness of the industry centers on the cost, quality, and quantity of standing timber. Table 6 shows that harvesting and transportation account for 50% to 80% of delivered roundwood costs. These cost components also need major attention.

Wood supply characteristics vary far more between mills within a region than they do between regions. Therefore, these data and conclusions may not fit any given mill.

CHIP COSTS. Most chips delivered to a mill are residues from lumber production, and there is little point in tracing sawlog stumpage and transportation costs through to the residue chips. Chip costs are basically debarking, chipping, and handling costs at the sawmill or plywood plant, plus transportation cost to the pulp mill.

Purchased chips are generally the least costly form of pulpwood supply, and there is no reason to expect change in the foreseeable future. Chip supply problems arise with the cycles in lumber and plywood production, which seldom match the paper cycle. This lumber and plywood market imbalance is strongest in the West and South and has minimal impact in other regions. Reduced harvest levels from federal lands in the West will eventually be felt in the pulp log market.

ROUNDWOOD COST PREDICTIONS. No problems are expected in the Northeast at this time as the supply is more than adequate. Those companies that have lost appreciable softwood volumes to the spruce budworm will have to use more hardwood in the future. Very little expansion is planned in the region. The use of wood for home heating is increasing, and there are prospects for the use of more wood for industrial fuel. However, such developments do not present a critical supply issue in the immediate future.

It looks like a buyer's market for Appalachian hardwood. A number of Appalachian mills also bring softwood from the South, and much of what pertains to the South applies to these mills as well.

In the Lake States, supplies of aspen—the predominantly used species—continue to look favorable, and no immediate problems seem to be forthcoming, although

TABLE 3: **Wood cost as a percent of pulp cost (1983).**

	Regions				
	NE (%)	AP (%)	LS (%)	S (%)	W (%)
Delivered wood	39	29	35	57	41

TABLE 4: **Wood cost as a percent of pulp cost (1973 and 1983).**

	Regions				
Delivered wood	NE (%)	AP (%)	LS (%)	S (%)	W (%)
1973	47	30	43	65	44
1983	39	29	35	57	41
	− 8	− 1	− 8	− 8	− 3

there are some hot spots of competition.

Western orientation toward solid wood and heavy dependence on purchased chips will keep pulpwood stumpage cost from becoming an important consideration over the short term.

The South is the only region where there is strong agreement that stumpage costs will be increasing. In a poll of American Pulpwood Assn. board members, half of the southern respondents said that stumpage cost increases had been the most significant economic component during the last ten years, and 60% said this would continue through the next five years. The basic reason is competition. There are also some hot spots, southern Georgia being the hottest, but competition is also very strong in other locations along the Atlantic Coast and the Gulf Coast.

For the rest of the 1980s, stumpage costs will probably not increase at the rate sustained during the last 10 to 15 years, and it is quite likely that the rate of increase will be less than that experienced in the past.

This assumption is based to a large degree on the current pessimistic forecast for housing starts, the likelihood that Canadian lumber will hold its current share of domestic markets and the probability that the export picture will not dramatically improve.

LIMITS TO UTILIZATION. The future will not be like the past. In the South, a number of events have occurred favorable to timber supply. Shifts in agriculture led to farm land abandonment, and fields often naturally seeded into pine stands. Increased forest fire protection was another such event, and the Soil Bank program, which paid farmers to pull marginal agricultural land out of production and plant it with trees, was still another. These events are unlikely to recur.

Other significant events, particularly for company-owned and controlled lands, were improved mechanical site preparation and controlled burning, forest fertilization, and genetics, all leading to increased yields from planted pines.

During past years, the degree of tree utilization has been improved, and more of the tree is being taken out of the forest. This has helped considerably in keeping costs down. However, tree-length harvesting is about as much as can practically be done with pine. As tree-length logging increases, it too will eventually reach its maximum practical application.

Technical improvement in residue chip production—chipping the whole tree, bark, leaves, and all—has some additional future promise, but use of this material is still constrained by its low quality for pulping. Stumps are another potential source of fiber, but ways must be found to get rid of the abrasive sand and grit. More hardwood is being used, a trend that will probably continue.

TABLE 5: **Effect of wood form and source on cost.**

	Regions				
Wood form/source	**NE (%)**	**AP (%)**	**LS (%)**	**S (%)**	**W (%)**
Roundwood					
Fee/lease	21	17	15	24	12
NIPF	53	50	44	34	5
Public	1	1	19	1	18
Chips					
Controlled	1	6	7	16	23
Open market	24	26	15	25	42

SUPPLY/DEMAND PREDICTIONS. Although the Forest Service has predicted doubled wood demand 50 years from now, industry managers, perhaps better tuned to past experience, domestic markets, and three-to-five-year business cycle horizons, are really not convinced. Periods of supply imbalance in the past were brief and were caused by logging contractors' inability to increase production rather than by a shortage of standing timber. If the pulp and paper industry's objective is to become a large factor in pulp and paper exports, it should be more concerned about increasing the wood supply 15 to 20 years in the future.

Planning is dependent on data, and the USDA Forest Service provides Forest Survey information in all regions, based on periodic remeasurement of thousands of permanently established statistical sample plots in the forests. Funding cuts lengthened the southern remeasurement cycle from once every 10 to once every 13 years. With pulpwood trees becoming merchantable in 20 to 25 years, 13-year-old data are not acceptable for substantiating mill expansion studies.

In the fall of 1983, the APA board of directors recommended action. Funds for reductions of the Southern Forest Survey cycle received congressional approval in late 1984. Cycle time reductions for other regions were also achieved.

On the demand side, the APA has been making five-year forecasts of southern pulpwood requirements for 20 years. These have proved statistically reliable in the long run and serve as an early warning guide. Good data on a timely basis for the South permit faster response. An eight-year resurvey cycle for pine is adequate for early warning.

About ten years ago, Virginia was faced with a timber growth/drain deficit. Spurred by industry and funded by an industry-accepted tax on harvest, the state planted trees in nonindustrial forests and reversed the drain. A similar initiative is now underway in several states. With most industry forests almost fully planted and growing close to capacity and with the public ownership contribution being minor, the opportunities are on nonindustrial private forestlands.

Only a comfortable surplus provides absolute security, and there is a question as to whether state-level action will be adequate. The perfectly managed forest would have equal acres in each age class through to maturity, but the reality of diverse ownerships and shifts in demand means that age classes are not going to be even. In low age class yield periods, some softwood will be harvested prior to reaching optimum size, and some hardwood substitutions will occur. States where supply deficits are identified will not be prime targets for expansion of mills. It is even likely that there will be some over-response in some areas, providing peaks in softwood timber supply.

HARVESTING/TRANSPORTATION COSTS. Harvesting and trucking pulpwood in the U.S. is predominantly performed by tens of thousands of small businessmen and women, independent of the companies that purchase their product or services. Logging by crews on pulp company payrolls is done by some companies but is responsible for only 5% or less of overall production.

Reliance on independent contractors gives the U.S. a significant cost advantage over other countries that get substantial supply from company operations. Canada, long highly dependent on company operations, is now strongly shifting to the use of independent contractors.

Over the next 20 years the independent operators will supply industry's needs only if they flourish economically. This means they must attract labor with adequate wages and benefits, provide a safe work environment, and increase labor productivity with training.

Independent contractors provide mills with a buffer on purchase volumes. When supply at the mill exceeds requirements, deliveries can be curtailed, and when more wood is needed, contractors are usually flexible enough to increase production to meet that need, up to a point. The elasticity of these small operations to increase production is finite, and the root cause of every pulpwood crunch we've experienced has been the inability of independent logging contractors to harvest and haul roundwood in excess of their capacity.

The primary cost issue in harvesting and hauling rests on the continuing independence of the relationship between pulpwood consuming mills and independent logging contractors. The principal challenges to this independence historically have come from the Internal Revenue Service's efforts to ensure full collection of income tax withheld and Social Security taxes. The IRS has attempted to transfer this responsibility to large corporations. After a three-year campaign in Congress, a very satisfactory solution has been achieved. However, in future years, if the IRS is able to prove to Congress that important revenue losses are inherent in the independent contractor system, the issue could be reopened. Labor union attempts to set aside the independent relationships for purposes of building units large enough to be administratively profitable have been random occurrences through the years, but there is currently no movement in progress.

When the APA board of directors was asked to rank the cost increase picture for the last ten years and predict the next five years, they found it clear that harvesting cost increases had minimal impact in the past. However, nearly 80% of APA board members felt that harvesting costs will increase at a higher rate in the coming five years. During the recession, harvesting costs remained flat or even declined. Reduced consumption levels maintained a buyer's market for pulpwood, and as the economy shifts to a seller's market, price pressure in harvesting is certain to occur. Demand will fuel the process, but the major harvesting cost increase will be based on logging and trucking equipment costs. During the recession, as the sales and profit pictures of the manufacturers of harvesting equipment and trucks dramatically show, loggers deferred equipment purchases. That situation has turned around, as have the prices for this equipment as well as the interest rates and carrying costs.

Eighty percent of APA board members also said that transportation was the cost area over the last five years that had experienced the highest overall rate of increase. Most of the increase was fuel-related, but some was tied to increases in truck equipment costs. Rail transportation, because it is most significant in the South, generated an overriding southern transportation cost increase. Rail deregulation has had dramatic cost consequences for many southern mills. Strategy to overcome the cost impact of higher rail rates, restrictions to the numbers of cars in the fleet capable of hauling short-length pulpwood, and the abandonment of unprofitable lines has forced many changes in wood procurement strategy. Company forestlands that were once considered strategic at long distances from the mill have lost some of that distinction. Measures to ensure the future supply of standing timber within favorable truck haul distances have been major factors in recent southern pulpwood procurement realignments. Decisions affecting company landownership and forest management assistance to nonindustrial private owners have, in recent years, been increasingly transportation cost driven.

However, the major transportation cost impact is probably behind us for the moment. Of the same APA board members who gave an 80% ranking on transportation cost increases during the past 10 years, only 20% feel that additional pressure in this component will occur during the next five years.

WORLD COMPETITION AND PUBLIC POLICY. How competitive is the U.S. compared with other countries that have significant forested regions? The industry is presently very competitive and has the talent to remain so. However Brazil, South Africa, Australia, New Zealand, and other countries have strong emerging industries based on highly productive land, advanced technology, and relatively low-cost labor. To remain competitive the pulp and paper industry must be prepared to compete.

While the cost-driven factors affecting wood supply on a regional basis have been covered with only passing reference to the impact of public policy, the pulpwood side of the forestry and harvesting community has fared reasonably well in the federal public arena. To a large extent, this is due to effective collective action through the trade associations that represent the industry at the federal level. With some exceptions in specific states, the industry has held its own at the state level. In the next several years, it is likely that critical public policy decisions will be made at the state level, and in some states, at the county and township level. These will have to be addressed, and the industry will probably have to concentrate its resources more strongly than ever at the state and local level. ■

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TABLE 6: **Delivered cost of roundwood by component.**

Roundwood cost component	Regions NE (%)	AP (%)	LS (%)	S (%)	W (%)
Stumpage	11	5	12	27	21
Harvesting	45	43	40	37	40
Transportation	34	26	31	16	30
Other	10	26	17	20	9

BLEACHING: Chemical substitutes, equipment increase efficiency

Consumption. Chemical pulp is whitened by the bleaching agents listed in Tables 1 and 2. The degree of brightness is usually a function of the product involved. Market pulp is at the top of the list while certain bleached board products are found at the lower end. The term "brightness" has recently come under some investigation. CPPA and TAPPI bleaching committees are currently working on a formula to equate the four measurements of whiteness (ISO%, GE, ELREPHO, and SCAN) to eliminate any market confusion.

Chemical consumption by chemical pulp bleacheries has been steady during the 1980s. Cheaper chemical substitutes such as oxygen and peroxide are reducing consumption slightly, but the major chemicals like chlorine dioxide are being shifted in bleaching sequences and becoming substitutes themselves. This results in a higher efficiency in chemical usage as well as an improved product. Dynamic mixing equipment sold to manufacturers is directly responsible for this development. Overall consumption figures will not change much in 1985, with no mill startups scheduled. Last year's mill startups at Great Northern Nekoosa's Leaf River Forest Products, New Augusta, Miss.; Union Camp, Eastover, S.C.; and Crown Zellerbach, Camas, Wash.; lifted consumption. Next year's opening of Champion International's Quinnesec, Mich., mill and possibly another southeastern mill will continue that growth.

Technology in electrochemistry and ozone bleaching and trends toward using mechanical pulp are still major, but not immediate, threats to bleach plant chemical consumption.

TABLE 1: **1984 U.S. consumption of chemicals for the bleaching of chemical pulp (in short tons) with their second quarter 1985 parice.**

Chemical	Bleaching process	All pulp and paper	All industry	Current price
Chlorine	1,489	1,489	11,100	200
Caustic	1,750	2,190	12,000	195
Sodium chlorate	296	296	350	440
Hydrogen peroxide	5	16	117	465[1]

1. Liquid, 35%, tanks, freight equalized.

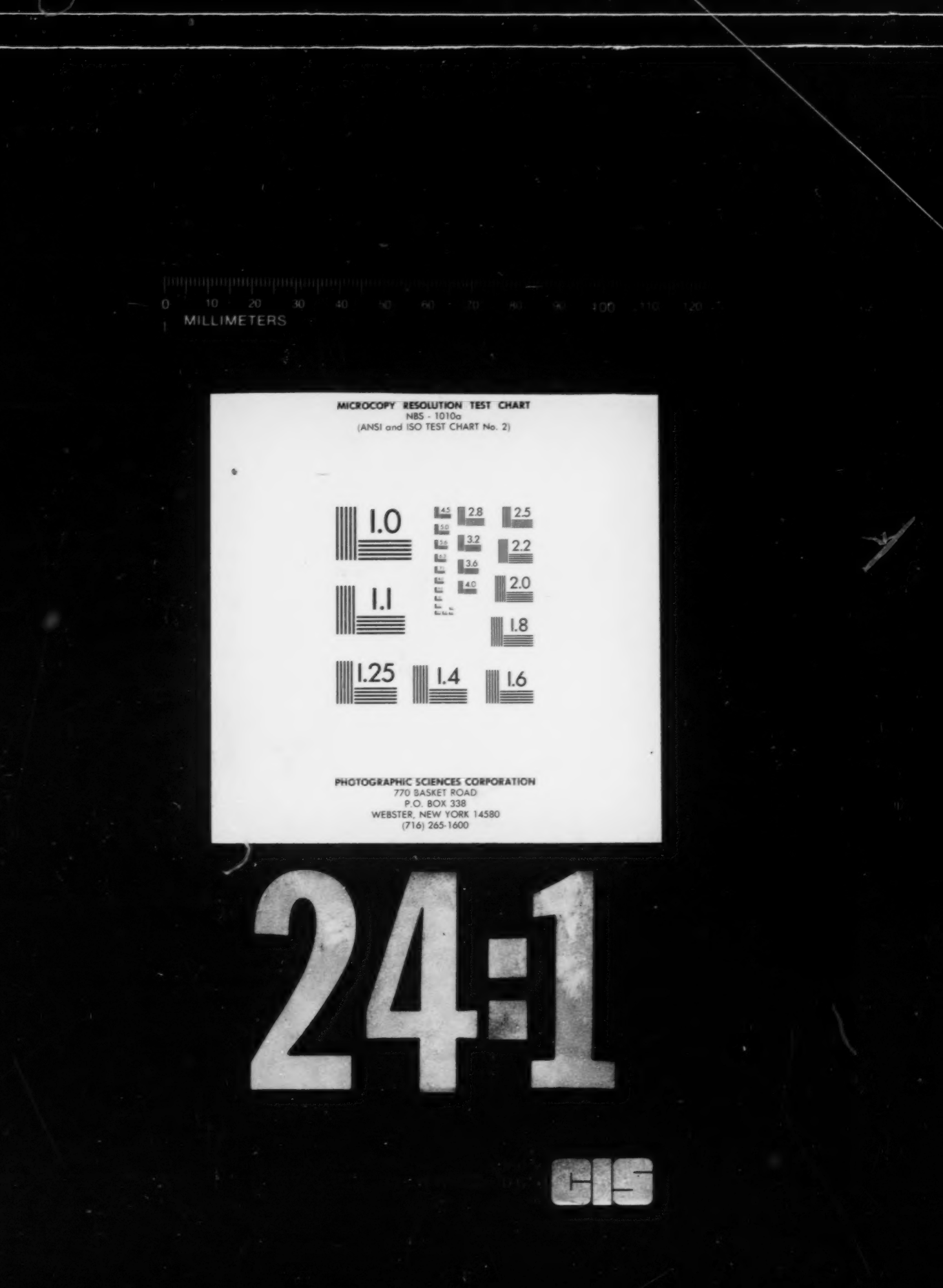
TABLE 2: **Bleaching agent action and market information.**

Chlorine	Liquid	100%	Tanks
Chemical action: Delignifies pulp according to dose, temperature, and reaction time.			
Caustic	Liquid	50%	Tanks
	Liquid	73%	Tanks
	Flake	76%	400-lb drum
	Solid	76%	700-lb drum
	Granular	76%	450-lb drum
	Bead	76%	400-lb drum
Chemical action: Neutralizes acids formed in previous stage; helps to remove chlorinated lignins while they remain in alkaline solution.			
Sodium chlorate	Crystal	100%	450-lb drums
	Liquid	100%	Bulk, tank car, or truck
Chemical action: Chief reactant in the production of chlorine dioxide. ClO_2 is specific in its attack on lignin and extractives.			
Hydrogen peroxide	Liquid	35%	Tanks
	Liquid	50%	Tank car
	Liquid	70%	Tank car
Chemical action: Mechanism for whitening is not known; oxidation of carbonyl and to carboxylic groups stabilizes pulp thus reducing brightness reversion.			

Prices. The cost of bleaching pulp fluctuated almost as much as pulp prices during the past 36 months. Chloralkali producers were discounting early in the decade as a result of the recession (decreased housing starts, etc.) and oversupply, but have recently stabilized their prices and are now introducing incremental price increases. Several U.S. producers idled chlorine plants in this period as well. A technological development in the production of chlorine and caustic soda could affect the purchase price. A new coating for cathodes in electrolytic cells has been tested by Dow U.S.A., and results indicate a savings in the voltage used to convert brine. Caustic soda is rapidly eating away the market share of sodium sulfate (saltcake) in pulping operations, bolstering demand.

The sodium chlorate and chlorine dioxide markets have been active as Canadian and U.S. producers continue to form partnerships. These ventures may be due to the cheap Canadian energy used to manufacture chlorate, which influences its price. Imports have been on the rise since 1979. One U.S. producer has announced a large capacity increase for 1987, as has a Canadian producer.

The inexpensive bleaching agents are both abundant and stable. Oxygen dealers are not overwhelmed by the increased use of oxygen in existing plants since this only entails a leased storage facility, vaporizer, and probably not more than 10 lb/ton of chemical applied to the pulp. However, the annual growth forecasted for North America (22%) is seen as the largest of any bleaching agent. Peroxide suppliers will be faced with more competition, both at home and abroad. Plans to build a plant in Quebec are currently taking shape, and two U.S. companies have already announced expansion projects. Chemical pulp bleacheries have been slow to substitute peroxide into their sequence since peroxide was not tied in with the growth of the new dynamic mixers (as oxygen was). The strongest growth area will remain with bleaching mechanical pulps. ■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MILLIMETERS
MICROCOPY RESOLUTION TEST CHART
NBS - 1010a
(ANSI and ISO TEST CHART No. 2)
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1.25
1.4
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